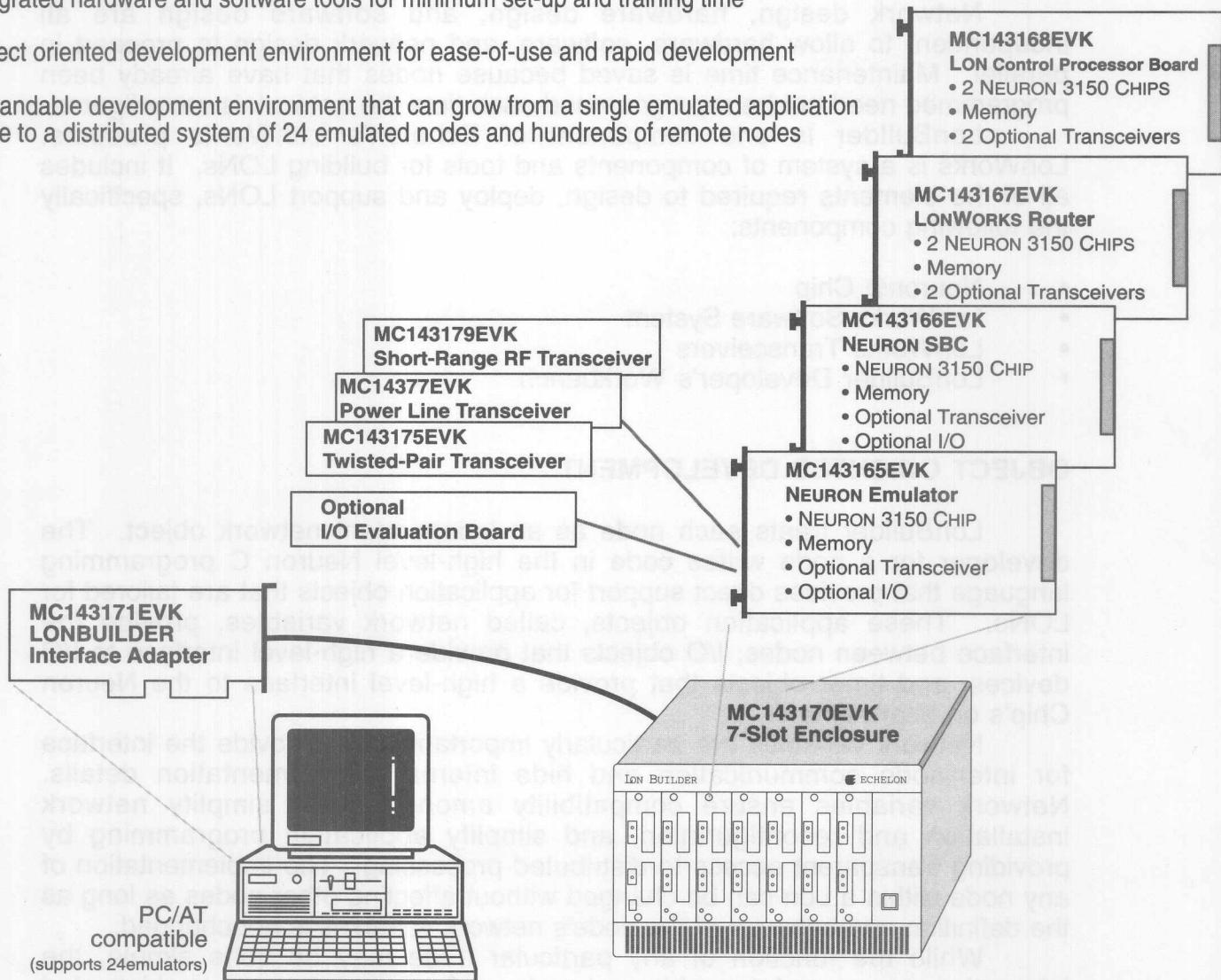


## PRODUCT PREVIEW

### LONBUILDER™ WORKBENCH

- Speeds development of applications for the MC143150 and MC143120 NEURON CHIPS™
- High-level NEURON C™ programming language allows programmers to concentrate on applications instead of spending time implementing low-level networking protocols and device drivers
- Source-level debugger and NEURON Emulator simplify debugging NEURON C applications
- Built-in network manager and protocol analyzer for flexible configuration, monitoring, and control of LONTALK™ networks during development
- Integrated hardware and software tools for minimum set-up and training time
- Object oriented development environment for ease-of-use and rapid development
- Expandable development environment that can grow from a single emulated application node to a distributed system of 24 emulated nodes and hundreds of remote nodes



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## OVERVIEW

The **LonBuilder Developer's Workbench** is an integrated hardware and software environment that provides the tools necessary to build Local Operating Networks (LONs).

LONs consist of intelligent nodes that interact with their environment, and communicate with one another over a variety of communications media using a common, message-based control protocol. Each node contains sufficient computing resources to implement the protocol and perform the node's control function. In addition, each node includes a transceiver that couples the node to the communications media.

LonBuilder provides a development environment that operates with an IBM PC/AT or compatible. This development environment can grow from a single emulated application node to a completely distributed system of up to 24 emulated nodes and hundreds of remote nodes.

Network design, hardware design, and software design are all independent to allow hardware, software, and network design to proceed in parallel. Maintenance time is saved because nodes that have already been programmed need not be reprogrammed each time the network is reconfigured.

LonBuilder is one component of Echelon's LonWorks products. LonWorks is a system of components and tools for building LONs. It includes all of the elements required to design, deploy and support LONs, specifically the following components:

- Neuron® Chip
- LonWorks Software System
- LonWorks Transceivers
- LonBuilder Developer's Workbench

## OBJECT ORIENTED DEVELOPMENT

LonBuilder treats each node as an independent network object. The developer for a node writes code in the high-level Neuron C programming language that provides direct support for application objects that are tailored for LONs. These application objects, called network variables, provide the interface between nodes, I/O objects that provide a high-level interface to I/O devices, and timer objects that provide a high-level interface to the Neuron Chip's on-board timers.

Network variables are particularly important; they provide the interface for inter-node communication and hide internal implementation details. Network variables ensure compatibility among nodes, simplify network installation and reconfiguration, and simplify application programming by providing transparent access to distributed processing. The implementation of any node within a Lon can be changed without affecting other nodes as long as the definition and behavior of the node's network variables is not changed.

While the function of any particular node may be quite simple, the interaction among nodes enables a Lon to perform complex and sophisticated tasks. For example, a reconfigurable lighting control system can be

implemented with just two nodes types: one that monitors the position of a dial (0 to 100%), and one that controls the brightness of a light. The network variables on these nodes may be connected so that a single switch node controls multiple light nodes, or a single light node responds to multiple switch nodes.

## **HARDWARE SUPPORT FOR DISTRIBUTED APPLICATIONS**

During development, LON applications will typically grow from a pair of communicating nodes to large networks of many nodes. Because a hardware development environment is required that can grow with the application it must be suitable for testing one or two nodes but capable of expanding to many nodes.

LonBuilder Development Station is a 7- slot enclosure complete with a power supply and LonBuilder processor boards. The Development Station includes two built-in nodes for managing and monitoring the developer's network and can accommodate up to six processor boards. An interface adaptor installed in the host PC provides high speed communications between the PC and up to four Development Stations.

### **LONBUILDER STARTER KIT (MC143160EVK)**

The LonBuilder Starter Kit contains all the components required to begin development with LonWorks technology using two emulated nodes communicating over the Development Station backplane network.

### **LONBUILDER DEVELOPMENT STATION (MC143161EVK)**

The development station is a complete platform for performing network management and protocol analysis of LonTalk networks during development.

### **LONBUILDER PROCESSOR BOARDS**

LonBuilder processor boards may be added to the LonBuilder Development Station to create LonWorks application nodes. The processor boards accept optional expansion boards that may be used for developing prototype I/O interfaces and transceivers. Optional transceiver evaluation boards are available from Motorola for twisted pair, RF, and powerline communications. The developer may also develop custom I/O or transceiver expansion boards.

To simplify network development, LonBuilder tools are independent of communication media. Initial development may start with a backplane network built into the Development Station. Transceiver expansion boards can be added or changed at any time to change the network media without affecting the software design. Multiple channels and multiple media are supported with optional LonBuilder Routers.

### **Control Processor Board (143168EVK)**

This board is the control hardware for a development station. It includes two MC143150 Neurons that are used by the Network Manager and Protocol Analyzer for controlling and monitoring a development network.

### **Neuron Emulator (MC143165EVK)**

Nodes are initially developed on the Neuron Emulator, which is a LonWorks node that supports source-level software debugging and hardware prototyping. The LonBuilder Neuron Emulator incorporates a MC143150 with 64 K of RAM. Software may be executed independently of target hardware to enable software development to occur even before hardware is available. Each Emulator board can support one or two expansion boards for testing with prototype I/O and transceiver hardware.

The Emulator provides hardware support for fast application download, source-level breakpoints, single-stepping, reset/start/stop, and memory read/write protection. The Emulator also provides a software controlled clock rate that may be set to 10 MHz, 5 MHz, 2.5 MHz, 1.25 MHz, or 625 KHz.

### **SBC (MC143166EVK)**

The LonBuilder SBC is a complete single board computer that may be used within the LonBuilder Development Station, or may be used remotely with a transceiver and user-supplied power to create a realistic network environment. Once the application software is debugged on the Emulator, it may be moved to a location remote from the Development Station using the LonBuilder Single Board Computer (SBC). The LonBuilder SBC incorporates an MC143150 Neuron with 64 KB of non-volatile RAM. The SBC accepts the same I/O and media interface expansion boards as the Emulator so that prototype I/O and transceiver hardware may be tested in a remote node.

### **Router (MC143167EVK)**

Networks with multiple channels and media may be constructed during development with the LonBuilder Router. The LonBuilder Router is a processor card incorporating two MC143150 Neurons and connections for two transceivers, to provide routing between two network channels. The LonBuilder Router may be configured as a learning router, a configurable router, or a bridge. When configured as a learning router, the LonBuilder Router monitors network traffic to learn the network topology. The Router uses the network topology information to selectively route packets between channels. When configured as a configurable router, the programmer can specify routing tables using LonTalk Network Management commands. When configured as a bridge, the LonBuilder Router forwards all packets between the two connected channels. The LonBuilder Router may be housed inside the LonBuilder Development Station or operated remotely with a user-supplied external power supply.

## **LONBUILDER TRANSCEIVER EVALUATION BOARDS**

Transceiver evaluation boards are optional expansion boards that may be installed on any LonBuilder processor board to provide the physical interface to a LonWorks network channel. Transceiver evaluation boards are available for twisted pair, powerline, and RF media.

### **Twisted-Pair Transceiver Evaluation Board (MC143175EVK)**

The Twisted-Pair Transceiver Evaluation Board provides the physical interface to a twisted pair network. The Neuron Chip can interface directly with a backplane network to communicate to a few nodes within a limited distance, the Twisted-Pair Transceiver Evaluation Board can be used to extend prototype networks to the maximum topological and performance boundaries of LonWorks on the twisted-pair media. The units are required in applications that require long distances and a large number of nodes on the network. The Twisted-Pair Transceiver Evaluation Board supports two data rates: 78 Kbps and 1.25 Mbps.

### **Powerline Transceiver Evaluation Unit (MC143177EVK)**

The Powerline Transceiver Evaluation Unit provides the physical interface to either 110 VAC or 277 VAC powerlines. The Powerline Transceiver Evaluation Unit provides a 9600 bps data rate modulated on high frequency carrier signals.

### **RF Evaluation Board (MC143179EVK)**

The Radio Frequency Transceiver Evaluation Board provides the physical interface to a Radio Frequency network. The Radio Frequency Transceiver Evaluation Board provides a 5000 bps date rate using a 49 MHz carrier.

## **LONBUILDER INTERACTIVE DEVELOPMENT ENVIRONMENT**

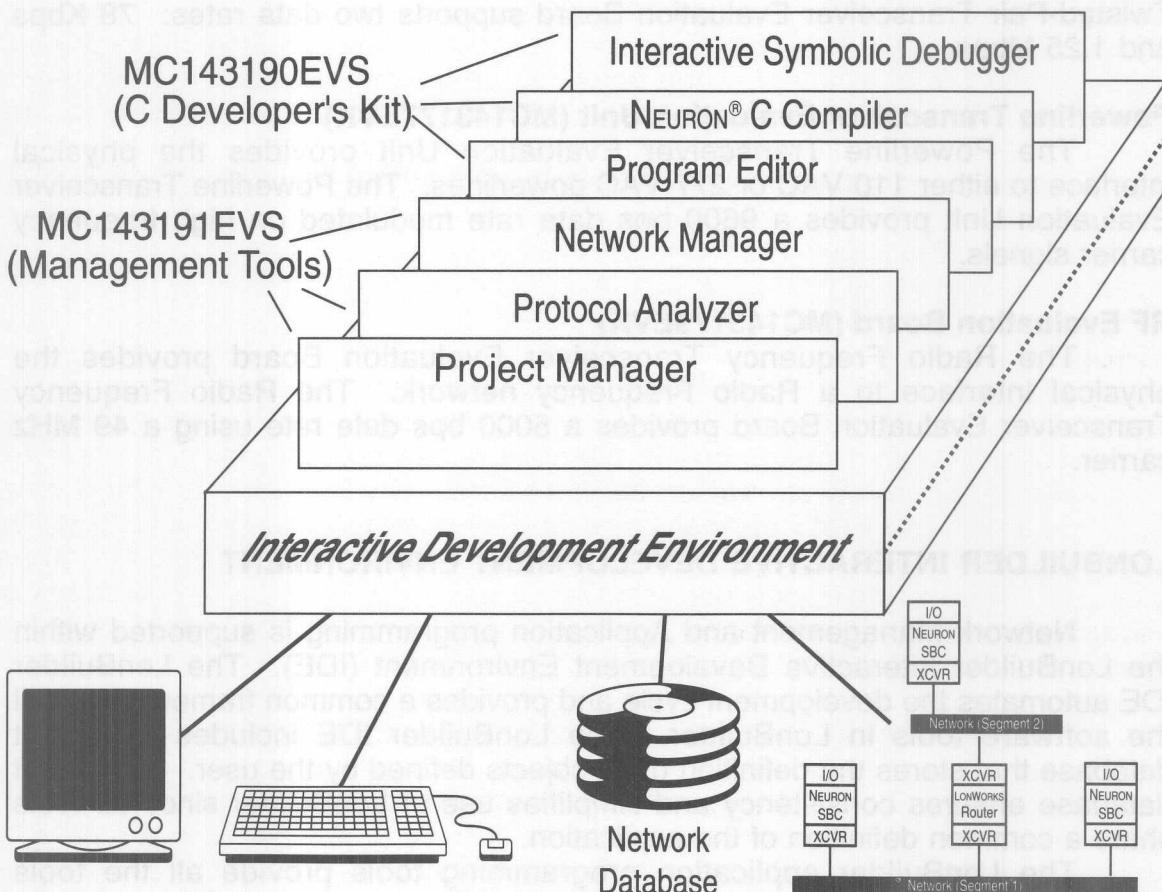
Network Management and Application programming is supported within the LonBuilder Interactive Development Environment (IDE). The LonBuilder IDE automates the development cycle and provides a common framework for all the software tools in LonBuilder. The LonBuilder IDE includes an object database that stores the definition of all objects defined by the user. The object database ensures consistency and simplifies use of LonBuilder since all tools share a common definition of the application.

The LonBuilder application programming tools provide all the tools required to edit, compile, and debug Neuron C applications. The tools are integrated to reduce training time and increase productivity. The application programming tools are in the optional Neuron C Developer's Kit.

## MC143190EVK LONBUILDER™ SOFTWARE

The MC143190EVK LONBUILDER™ Software is a complete development environment for the MC143190. It includes a C compiler, a symbolic debugger, a management tool, and a graphical interface for configuration and monitoring of the MC143190.

### LONBUILDER™ SOFTWARE



The MC143190EVK LONBUILDER™ Software is a complete development environment for the MC143190. It includes a C compiler, a symbolic debugger, a management tool, and a graphical interface for configuration and monitoring of the MC143190.

## **LONBUILDER MANAGEMENT TOOLS (MC143191EVS)**

Traditional emulators and debuggers are not sufficient for developing distributed applications. They tend to focus on the development of software for a single processor and cannot be easily expanded to a networking environment. Without sufficient tools, developers must spend time creating custom tools for debugging and managing distributed applications.

LonBuilder solves networking problems by including the tools required to define, configure, load, monitor, and control multiple nodes in a networking environment. The Development software includes the **Project Manager** and two network management tools: The LonBuilder **Protocol Analyzer** and the LonBuilder **Network Manager**. The LonBuilder Network Manager provides the tools required to define, configure, load, and control LonWorks networks. The LonBuilder Protocol Analyzer provides capability to monitor, collect, and display network traffic and network performance statistics.

### **Project Manager**

The LonBuilder IDE incorporates a project manager that manages the configuration of objects within the object database and provides the developer with the capability to build an application based on the object database definitions. If application source files have changed, the project manager runs the optional Neuron C Compiler to compile the application programs. Once an application is compiled, the project manager runs the network management tools to build the network configuration information, load the application, and start execution.

### **Protocol Analyzer**

The LonBuilder Protocol Analyzer provides the capability to selectively monitor, collect, and display network traffic and network performance statistics. The Protocol Analyzer uses one of two built nodes built into the Development Station to monitor network traffic. Network traffic may be saved to a log file for later display. The Protocol Analyzer simplifies interpretation of the packets by decoding the packet contents and displaying a symbolic representation of the packets. For example, network variable transactions are displayed in terms of source node name, destination node name, network variable name, and the new value of the network variable. Each packet is time stamped to support real-time performance analysis.

Packets can be filtered based on source node, destination node, packet type, and network variable. Source node and destination node filters can be used to collect only those packets exchanged between a pair of nodes. Network variable filters can be used to limit the log to specific network variable updates. The Protocol Analyzer also maintains network statistics and allows the user to display a summary of network performance, packet counts by packet type, and error rates.

## Network Manager

The LonBuilder Network Manager uses a network management node within a Development Station to send network management commands to other Emulator, SBC, Router, and custom nodes within the development network. The user defines a new network by using the Network Manager to define network objects within the development network. Each node is defined in terms of its physical characteristics and the name of the application program for the node. Once the application program is written, the Network Manager creates the required information for configuring each node and downloads the information over the network to the application nodes. The Network Manager controls nodes over the network by providing user commands to put nodes online, take nodes offline, reset nodes, read node memory, write node memory, and test nodes. It also maintains a summary display of the status of all nodes on the network

## NEURON C DEVELOPER'S KIT (MC143190EVS)

The LonBuilder IDE also includes an integrated **Program Editor** for creating application programs. The editor is integrated with the optional Neuron C Compiler so that errors identified by the compiler are easily found and corrected. The Neuron C Developer's Kit includes the **Neuron C compiler** and the **Neuron C Debugger**. The Neuron C Compiler and Neuron C Debugger are optional components of the LonBuilder Interactive Development Environment. The Neuron C Compiler is a cross compiler that takes as input Neuron C source code stored on the PC and generates code that is stored in the object database for subsequent downloading by the LonBuilder IDE. The Neuron C Compiler can generate code for either the MC143120 or the MC143150. The Neuron C Debugger is a cross debugger that runs on a PC host while debugging Neuron C applications running on from 1 to 24 LonBuilder Emulators. The Neuron C Debugger provides a full-screen source-level view of application programs executing on LonBuilder Emulators. The developer uses the source-level views to set breakpoints, start and stop program execution, and single-step through the programs. The programmer can also evaluate and modify program variables using the Neuron C symbolic names. The Neuron C Debugger can display the call stack and change the current context to any function within the stack.

## LONBUILDER STARTER KIT (MC143160EVK)

The LonBuilder Starter Kit contains all the tools necessary to begin LonWorks development on a PC/AT or compatible computer. The starter kit contains a LonBuilder Development Station (7-slot enclosure and PC interface adapter board) and the Interactive Development Environment Software consisting of the Network Management Tools and the Neuron C Developer's Kit. The starter kit also contains two LonBuilder Neuron Emulators. The backplane built into the enclosure can be used as an internal development network or optional LonBuilder transceiver evaluation boards are available for external powerline, radio frequency, and twisted pair networks.

## LONBUILDER DEVELOPMENT STATION (MC143161EVK)

The development station is a complete platform for performing network management and protocol analysis of LonTalk networks during development. It does not contain the Neuron C Developers Kit software for application program development. It also does not have include the two LONBUILDER emulators which the Starter Kit contains.

### Hardware Requirements

LonBuilder requires an IBM PC/AT compatible computer with 1 available 8 or 16-bit slot, EGA or VGA compatible graphics adaptor, 640 KB RAM, 1.5 MB extended or LIM 4.0 expanded memory, MS-DOS or PC-DOS version 3.3 or 4.0, a Microsoft-compatible mouse, and a hard disk with 10 MB of available space. LonBuilder software is distributed on 1.2 MB 5 1/4" and 720 KB 3 1/2" diskettes. The development station requires the same hardware as the Starter Kit. The Neuron C Developers Kit and Neuron Emulators are required for developing Neuron C applications.

## PART NUMBERS

Part #	Description
	<b>LONBUILDER Development Systems</b>
MC143160EVK	<b>LonBuilder Starter Kit</b>  <b>Hardware</b> <ul style="list-style-type: none"> <li>• 1 LonBuilder Interface Adaptor for the IBM PC (MC143171EVK)</li> <li>• 1 LonBuilder 7-Slot Enclosure (MC143170EVK)</li> <li>• 1 LonBuilder Control Processor (MC143168EVK)</li> <li>• 2 LonBuilder Emulators (MC143165EVK)</li> </ul> <b>LONBUILDER Management Tools (Software)</b> (MC143191EVS) <ul style="list-style-type: none"> <li>• LonBuilder Network Manager</li> <li>• LonBuilder Protocol Analyzer</li> <li>• LonBuilder Project Manager</li> </ul> <b>Neuron C Developer's Kit (Software)</b> (MC143190EVS) <ul style="list-style-type: none"> <li>• Neuron C Compiler</li> <li>• Neuron C Debugger</li> <li>• Neuron C Editor</li> </ul>
MC143161EVK	<b>LonBuilder Development Station</b>  <b>Hardware</b> <ul style="list-style-type: none"> <li>• 1 LonBuilder Interface Adaptor for the IBM PC (MC143171EVK)</li> <li>• 1 LonBuilder 7-Slot Enclosure (MC143170EVK)</li> <li>• 1 LonBuilder Control Processor (MC143168EVK)</li> </ul> <b>LONBUILDER Management Tools (Software)</b> (MC143191EVS) <ul style="list-style-type: none"> <li>• LonBuilder Network Manager</li> <li>• LonBuilder Protocol Analyzer</li> <li>• LonBuilder Project Manager</li> </ul>
	<b>LONBUILDER Processor Boards</b>
MC143168EVK	LonBuilder Control Processor Board
MC143165EVK	LonBuilder Emulator
MC143166EVK	LonBuilder Single Board Computer (SBC)
MC143167EVK	LonBuilder Router Evaluation Board
	<b>LONBUILDER Transceiver Evaluation Boards</b>
MC143177EVK	LonBuilder Powerline Transceiver Evaluation Unit
MC143179EVK	LonBuilder RF Transceiver Evaluation Board
MC143175EVK	LonBuilder Twisted Pair Transceiver Evaluation Board

<b>Development Station Expansion Hardware</b>	
MC143171EVK	LonBuilder Interface Adapter Board
MC143170EVK	LonBuilder 7-Slot Enclosure
<b>LONBUILDER Software</b>	
MC143190EVS	Neuron C Developer's Kit <ul style="list-style-type: none"> <li>• Neuron C Compiler</li> <li>• Neuron C Debugger</li> <li>• Neuron C Editor</li> </ul>
MC143191EVS	LONBUILDER Management Tools <ul style="list-style-type: none"> <li>• LonBuilder Network Manager</li> <li>• LonBuilder Protocol Analyzer</li> <li>• LonBuilder Project Manager</li> </ul>

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